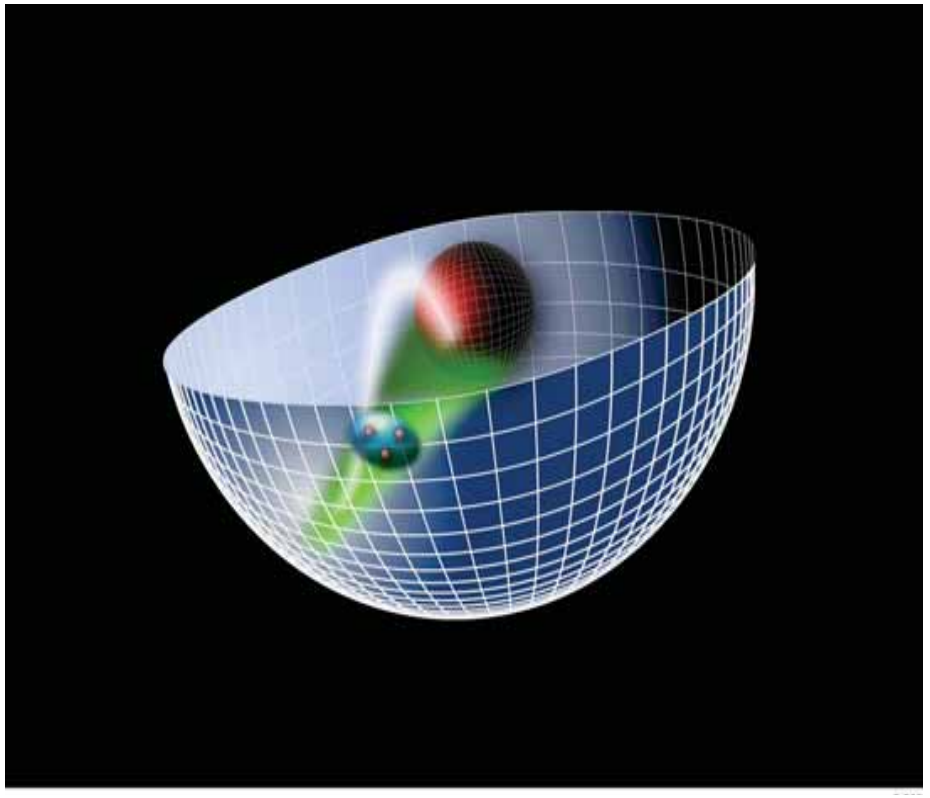
Light-Front Holography and Non-Perturbative QCD



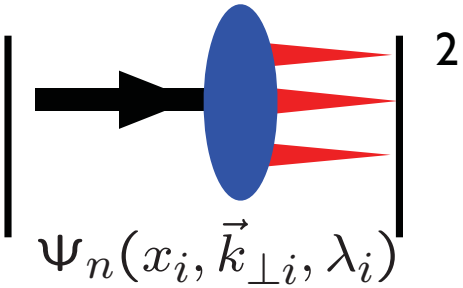
Stan Brodsky, SLAC

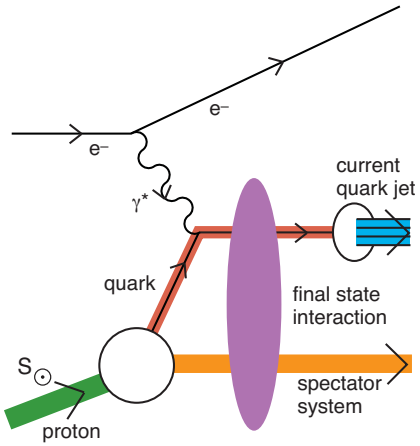
LC2009
Light-Cone 2009: Relativistic Hadronic and Particle Physics
July 8-13, 2009
Instituto Tecnológico de Aeronáutica (ITA)
Comando-Geral de Tecnologia Aeroespacial (CTA)
São José dos Campos, Brazil

Discussion points: Hadron Structure

- Bethe-Salpeter Approach - truncation issues - gauge dependence, zero modes, relation to LF Hamiltonian theory
- PQCD Factorization -- "Static vs. Dynamic" Structure Functions, Rescattering
- Comparison with AdS/QCD and Light-Front Holography Spectrum and LFWFs.
- Confinement Potential -- Coulomb + HO for quarkonium
- Heavy-Light systems, decays
- Lattice and HLF comparison-- sea quark anti-symmetrization issues, renormalization methods, implementation of MSbar and other schemes, gluon polarization issues
- Chiral Field Theory - Where applicable? Infinite proton size for zero pion mass -- linear divergence for Pauli radius
- Comparisons of models with LGTH and Experiment
- Timelike and Spacelike Form Factor; Photon to Meson Transition form factors
- Spin Sum Rule -- Different Definitions (Burkardt)

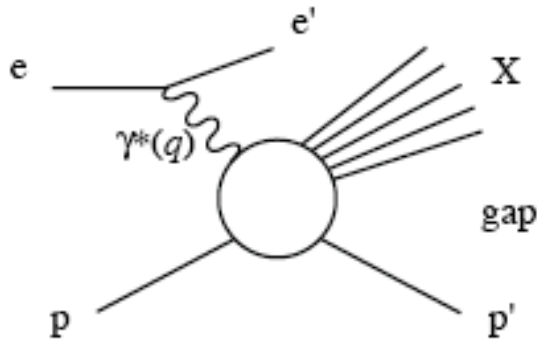
Static	Dynamic
Square of Target LFWFs	Modified by Rescattering: ISI & FSI
No Wilson Line	Contains Wilson Line, Phases
Probability Distributions	No Probabilistic Interpretation
Process-Independent	Process-Dependent - From Collision
T-even Observables	T-Odd (Sivers, Boer-Mulders, etc.)
No Shadowing, Anti-Shadowing	Shadowing, Anti-Shadowing, Saturation
Sum Rules: Momentum and J^z	Sum Rules Not Proven
DGLAP Evolution; mod. at large x	DGLAP Evolution
No Diffractive DIS	Hard Pomeron and Odderon Diffractive DIS





DDIS

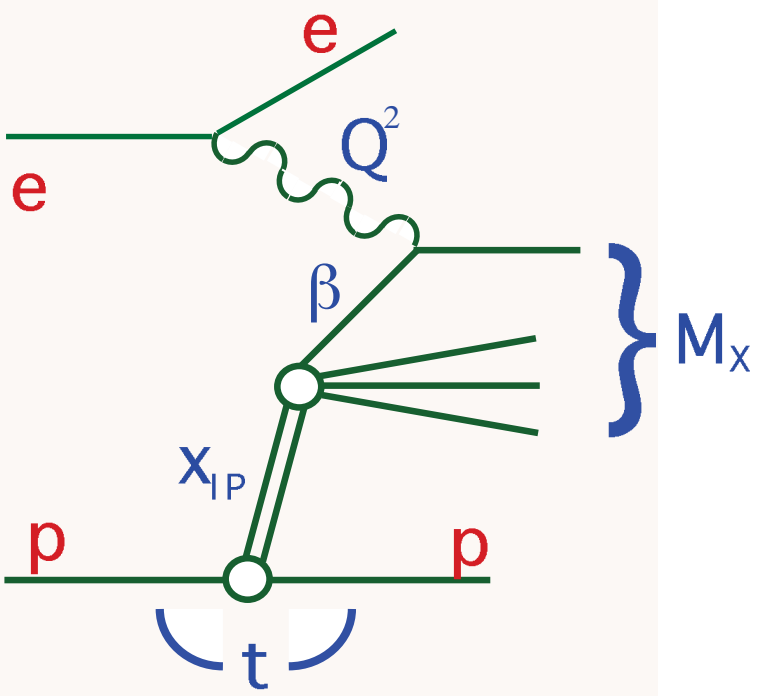
Diffractive Deep Inelastic Lepton-Proton Scattering



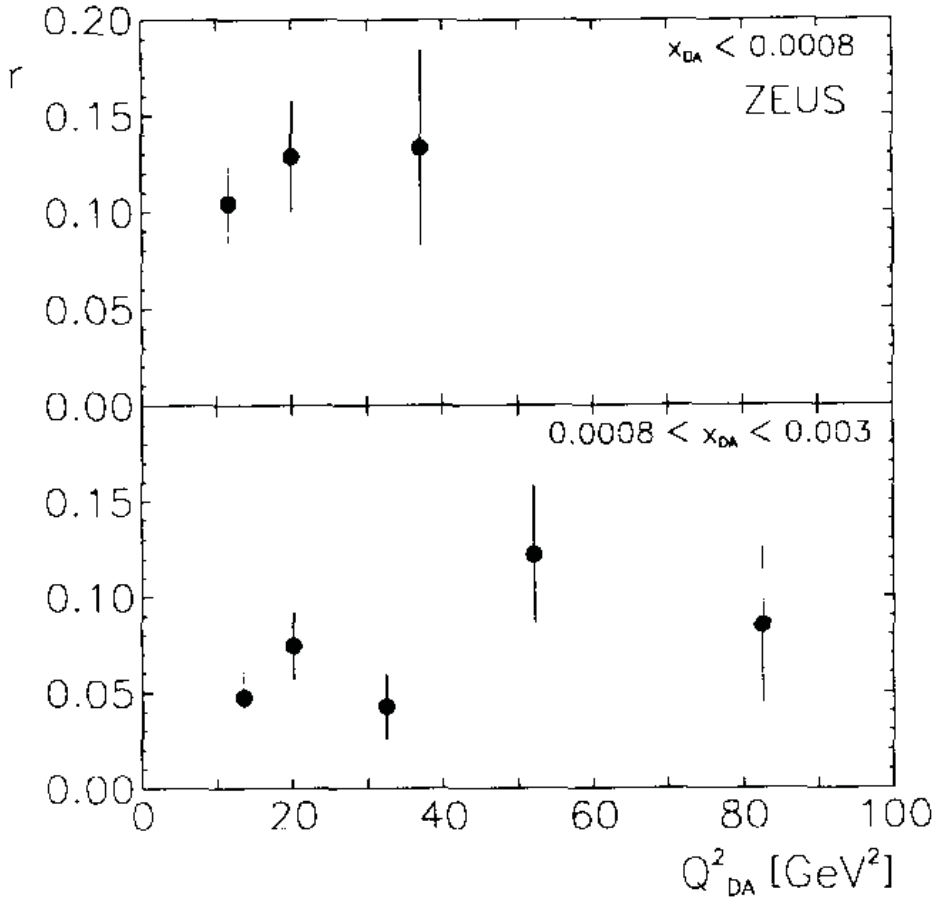
- In a large fraction ($\sim$ 10–15%) of DIS events, the proton escapes intact, keeping a large fraction of its initial momentum
- This leaves a large *rapidity gap* between the proton and the produced particles
- The t-channel exchange must be *color singlet* $\rightarrow$ a pomeron

Profound effect: target stays intact despite production of a massive system X

Remarkable observation at HERA



10% to 15% of DIS events are diffractive !



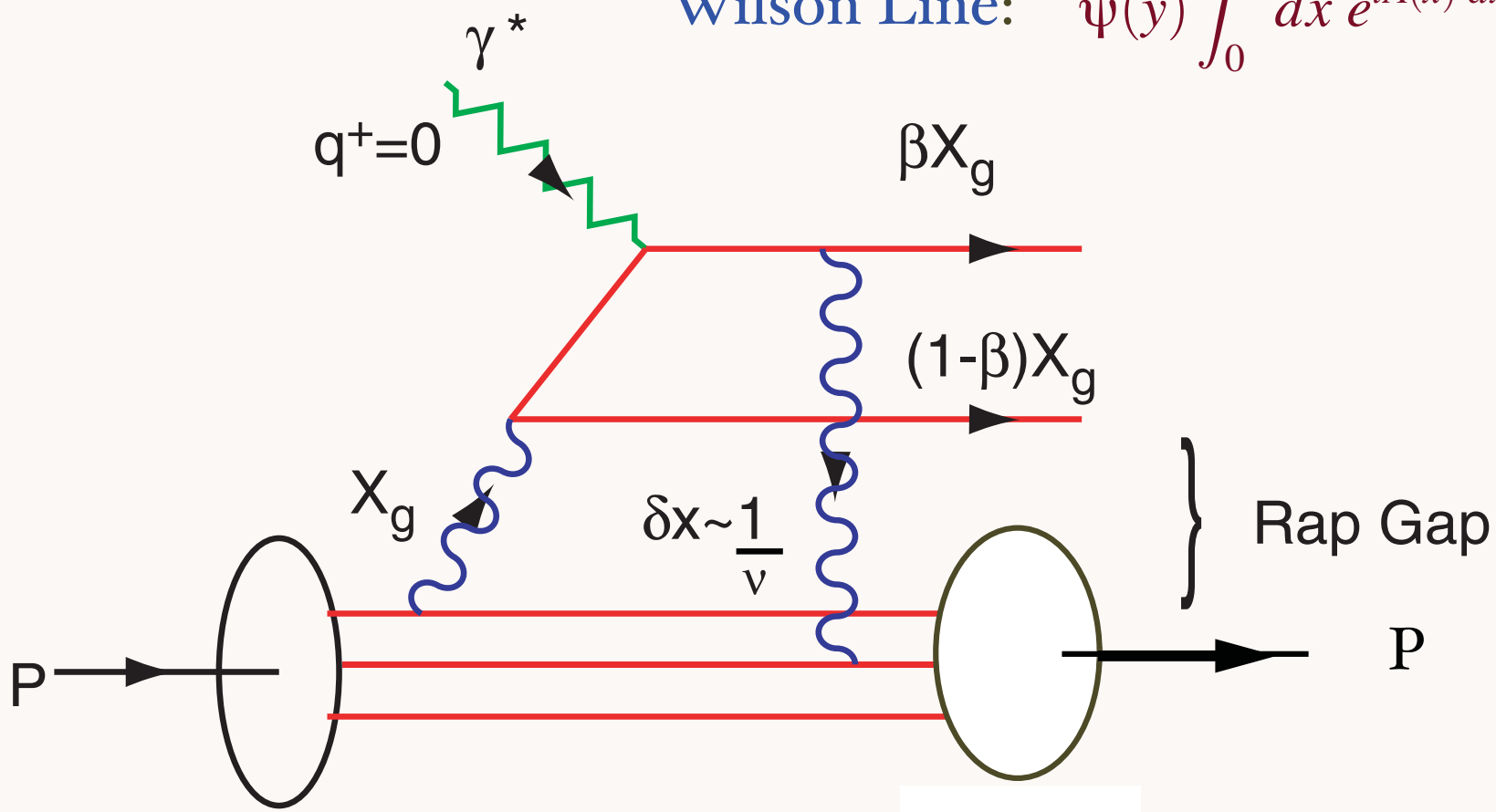
Fraction r of events with a large rapidity gap, $\eta_{max} < 1.5$, as a function of Q^2_{DA} for two ranges of x_{DA}. No acceptance corrections have been applied.

M. Derrick et al. [ZEUS Collaboration], Phys. Lett. B 315, 481 (1993).

Hoyer, Marchal, Peigne, Sannino, sjb

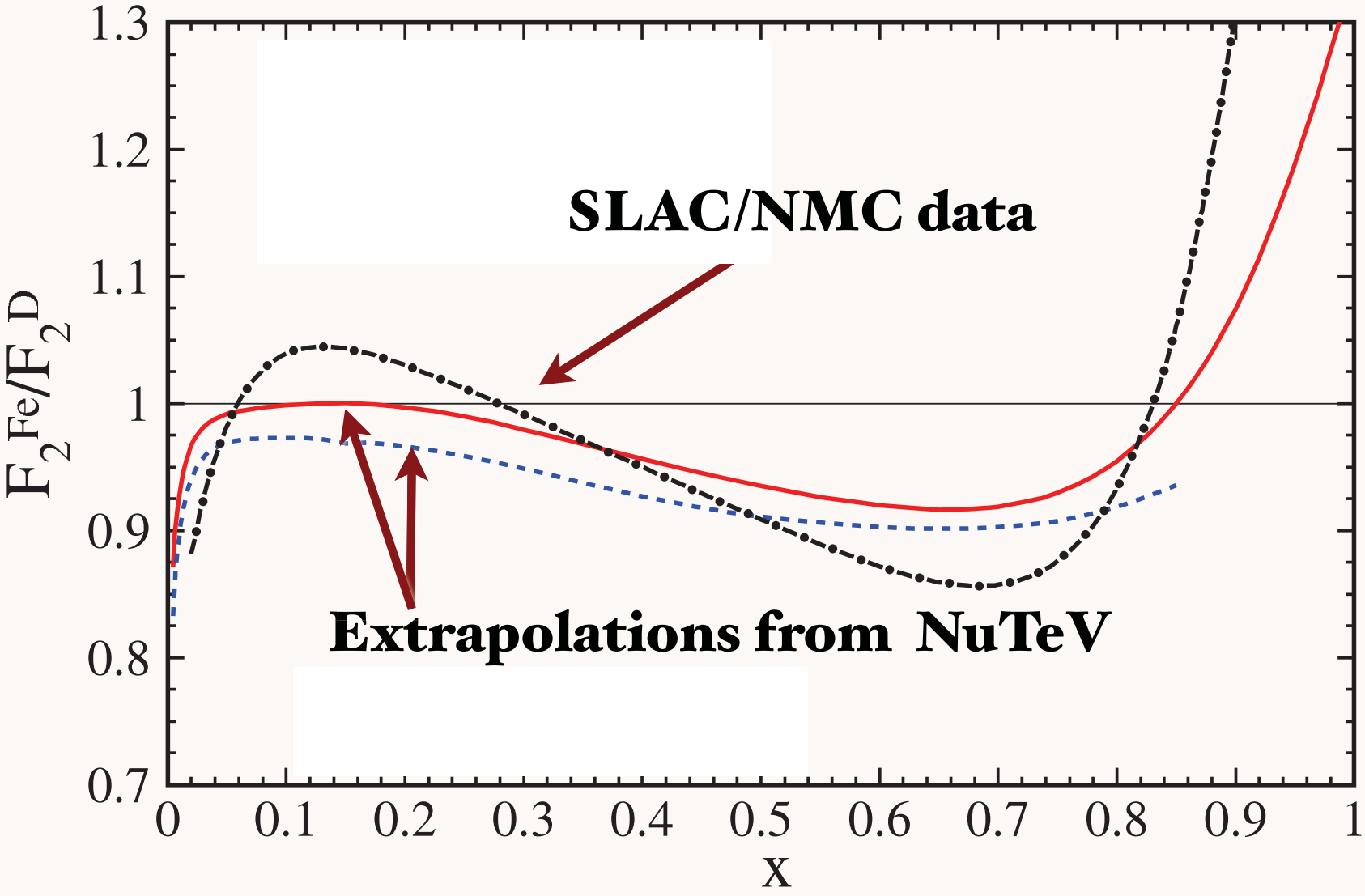
QCD Mechanism for Rapidity Gaps

Wilson Line: $\overline{\psi}(y) \int_0^y dx\, e^{iA(x)\cdot dx}\, \psi(0)$



Reproduces lab-frame color dipole approach

$$Q^2 = 5\ \mathrm{GeV}^2$$



Scheinbein, Yu, Keppel, Morfin, Olness, Owens

Shadowing and Antishadowing in Lepton-Nucleus Scattering

- Shadowing: Destructive Interference

of Two-Step and One-Step Processes

Pomeron Exchange

- Antishadowing: Constructive Interference

of Two-Step and One-Step Processes!

Reggeon and Odderon Exchange

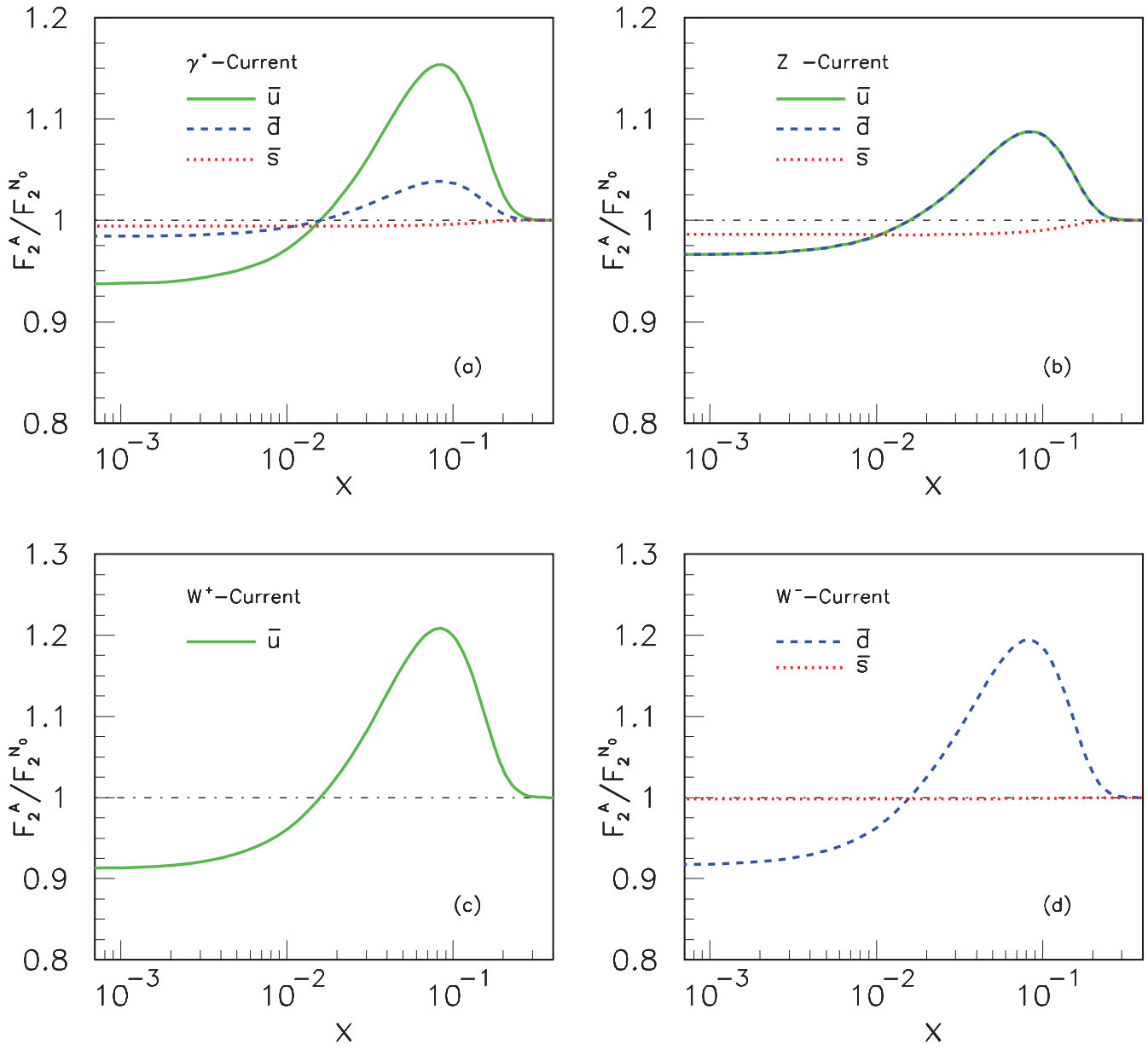
- Antishadowing is Not Universal!

Electromagnetic and weak currents:

different nuclear effects !

Potentially significant for NuTeV Anomaly}

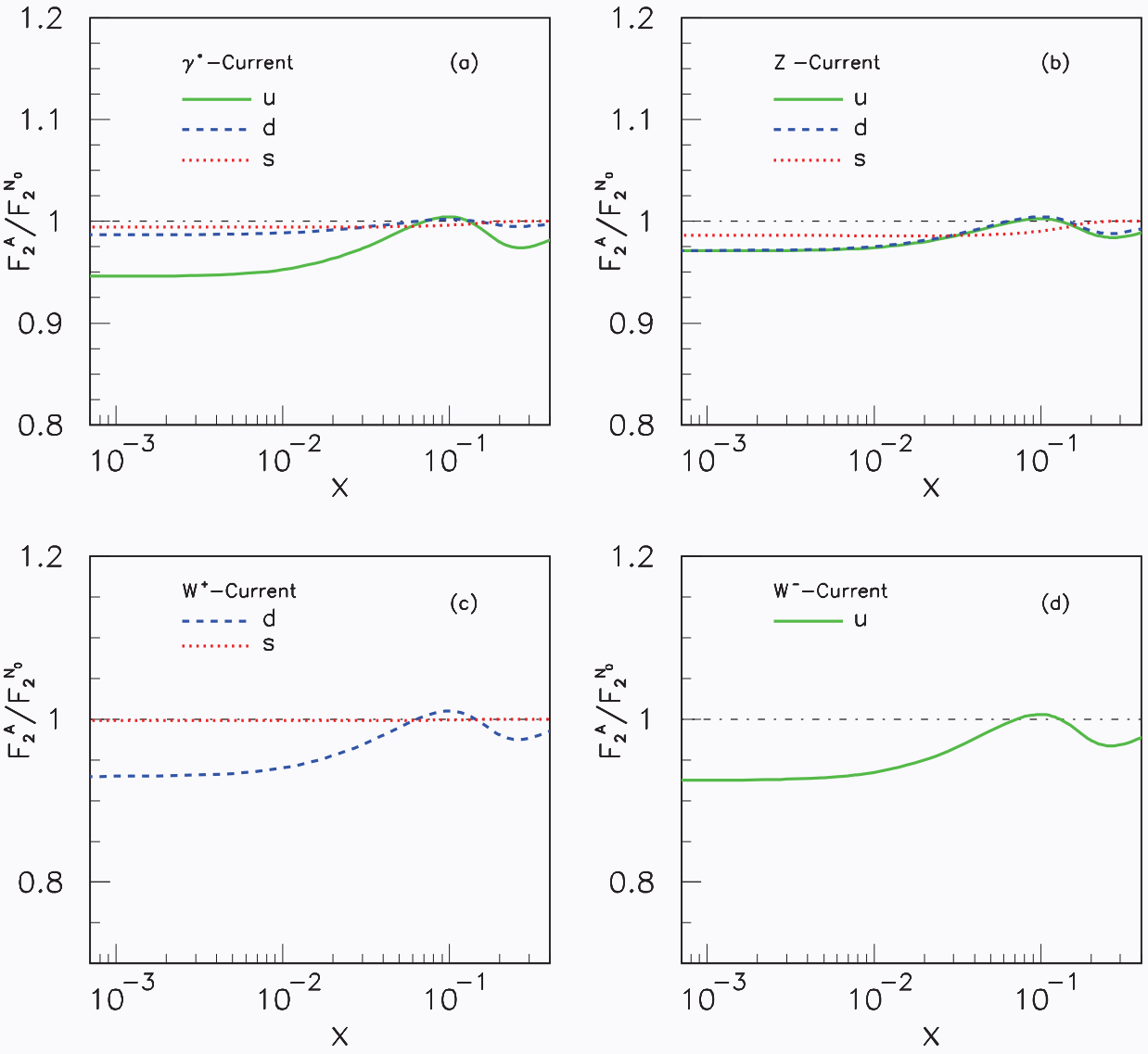
Jian-Jun Yang
Ivan Schmidt
Hung Jung Lu
sjb



Schmidt, Yang; sjb

Nuclear Antishadowing not universal !

Shadowing and Antishadowing of DIS Structure Functions



S. J. Brodsky, I. Schmidt and J. J. Yang, "Nuclear Antishadowing in Neutrino Deep Inelastic Scattering," Phys. Rev. D 70, 116003 (2004) [arXiv:hep-ph/0409279].

Modifies NuTeV extraction of

$$\sin^2\theta_W$$

Test in flavor-tagged lepton-nucleus collisions